Two Talks on Geometric Modelling of Physical Solids. I—CAD/CAM: Computer Aided/Automated Design and Manufacturing. II—PMC: A Case Study in Computational Geometry. Aristides A. G. Requicha (Production Automation Project, University of Rochester, Rochester, New York 14627, USA).

Computer-based systems for modelling the geometric aspects of physical solids are becoming increasingly important in mechanical and civil engineering, architecture, computer graphics, computer vision, and other fields that deal with spatial phenomena. These talks provide an introduction to an emerging body of knowledge that is concerned with the mathematical and computational issues that arise in the design, assessment, and practical use of such modelling systems.

The first talk describes the role of geometric modelling in the automatic and computer-aided design and manufacture of mechanical parts and assemblies, and outlines an abstract framework in which geometric modelling problems can be formulated precisely and solved. Four central issues are identified: (1) modelling of solid objects, (2) calculation of properties of objects, (3) modelling of processes which modify objects, and (4) planning of sequences of transformations to produce specified solids.

The second talk is a detailed case study of a simple but important problem, dubbed PMC (for point/solid membership classification), which illustrates the interplay between mathematics and computation in geometric modelling. PMC consists of determining whether a point in Euclidean 3-space ($E3$) is in the interior, the boundary, or the complement of a subset of $E3$ that models a physical solid. PMC algorithms for solids represented by constructive solid geometry trees, i.e., as set-theoretical compositions of primitive building blocks, are developed by using a blend of mathematical notions from point set topology and algorithmic paradigms from computer science. Various important generalizations of PMC which raise interesting mathematical and algorithmic problems are also discussed.

Algebraic Geometry Foundations for Finite Element Computation. E. L. Wachspress (General Electric Company, Schenectady, New York 12305, USA).

Nodal basis functions are the core of the finite element method. An intimate relationship between element geometry and algebraic properties of associated basis functions can be exploited with the aid of fundamental results from the theory of algebraic geometry. That Max Noether's fundamental theorem and modern algebraic geometry can be used effectively in analysis of a problem of central concern to numerical analysts and applied mathematicians is most gratifying. This unique application of classical geometry provides theoretical foundations for construction of rational basis functions for any prescribed degree of approximation over a wide class of elements.

Current Research Involving Applications of Geometry to Finite Element Computation. E. L. Wachspress (General Electric Company, Schenectady, New York 12305, USA).

A class of elements for which rational basis functions are numerically expedient is described. Means for achieving higher order approximation within elements are discussed, including higher order isoparametric elements and generalized isoparametrics.